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USPS Residential and Small Med Business CEM Survey Data Weighting Overview

Purpose of Weighting

Weighting will be done to accurately estimate the true population scores.

Sampling Method

A Stratified random sample will be taken on a quarterly basis. The strata for these studies will be the Performance Cluster (PC). Each PC has a target of 1,067 surveys. A random selection of households and businesses are sampled each month and are nvited to participate in a CEM survey in order to achieve this target in a balanced manner across the quarter.

Sample Structure

For the purpose of weighting survey results, the standard geographical organization of the USPS will be used. National level results will be divided into eight areas. Each area contains 9-15 PC's and each PC has a set of 3-digit ZIP CODES. The strata for sampling is the PC, however the level for weighting will be at the 3-digit ZIP CODE level.

Weighting Goals

Weights will be determined to appropriately reflect the number of businesses/households represented by the survey returns generated by the sampling method. This will be accomplished by assigning weights to adjust scores to account for differences or issues in household or business populations.

Issues

1) RESPONSE VARIABILITY: With this sampling structure each PC is targeted at the same level to obtain a representative sample of household or business population for that PC. However, since the population represented by each PC is not equal, some PC's will be overrepresented and some will be under represented when aggregating results to higher levels if results are not weighted.
2) RANDOM VARIATION: It is expected that random sampling should keep the 3-digit ZIP CODES balanced within a PC. However, to correct for any imbalance, the data will be weighted at the 3-digit ZIP CODE level.

Weighting Method—Simultaneous Weighting and Projection (S.W.A.P)

S.W.A.P. will be the method of developing the weights for CEM Residential and Small Medium Business survey results. In S.W.A.P. weighting each respondent is assigned a weight (one weight per survey record). The weight corresponds to the number of respondents each is projected to represent in the population. Within the weighting cell all respondents have the same weight. The general formula for any weighting cell is as follows:

$$\frac{\text{Population count}}{\text{Return survey count}} = \text{S.W.A.P. Weight}$$

Once a weight has been established, scoring of any level above the weighting cell can be calculated. For any level of scoring all respondents for that segment (geographic grouping) are used for a calculation. Then, any score is calculated as a weighted score for that segment. Since each respondent is assigned a weight, for whatever combination of respondents may be used, the weight will be appropriate. The general formula for scoring with S.W.A.P. weighting is as follows:

$$\frac{\text{Sum of [weight} \times \text{all respondents in group's score]}}{\text{Sum of all respondents' weights}} = \text{group score}$$

A special feature of S.W.A.P. weighting is that the weighted sample size is an estimate of the population represented for the particular time period of the weighting cell, and will be determined through established business rules for processing and reporting time periods [Kish. L. (1965). *Survey sampling*, New York, NY: Wiley].

Types of Weights—Timing, Quantity and Usage of Weights

Scoring is being reported for three time periods on the Residential and Small Medium Business USPS surveys. Standard scoring is on a quarterly basis, however there will also be scoring on a monthly and yearly basis. Each of these will be reported at the end of each period, and for the quarterly and yearly time periods a 'to-date' score will be created. The quarter-to-date (QTD) or year-to-date (YTD) can be reported in months prior to the end of a quarter or year. This necessitates the creation of three weights, a monthly, a quarterly and a yearly weight. It will be important to use the appropriate weight for the matching time period. Monthly scores will use a monthly weight, quarterly or QTD scores will use a quarterly weight and yearly or YTD scores will use a yearly weight. Weights will be updated monthly, with scores stored as necessary for reporting needs such as trending.

Weighting Design for USPS Residential and Small Medium Business Data

The Residential and Small Medium Business USPS surveys will use S.W.A.P. weighting. Each study will have weights updated on a monthly basis. The two surveys will be weighted separately. However the method will be identical with the exception that the population of the residential survey is the number of households, and the population of the small medium business survey is the number of businesses.

The studies are sampled with a quarterly design, so the standard weight is the quarterly weight. A quarterly weight is calculated each month. Prior to the completion of a quarter, scores calculated with the quarterly weight are quarter-to-date scores. At the end of a quarter the quarterly weight generates the quarterly scores. Since the sample period does not close until the end of the quarter, the quarterly weight changes until the quarter is complete, even though they are reported monthly they are not finalized till the end of a quarter (see Table 1 for illustration).

Table 1

			Weights							
			Jan Data View		Feb Data View		Mar Data View		Apr Data View	
ID	Month of Return	3-digit ZIP	Mthly.	Qtrly.	Mthly.	Qtrly.	Mthly.	Qtrly.	Mthly.	Qtrly.
1	Jan	001	45*	45	45	56	45	35	45	35
2	Feb	001	-	-	44	56	44	35	44	35
3	Mar	001	-	-	-	-	62	35	62	35
4	Apr	001	-	-	-	-	-	-	49	28
5	Jan	002	56	56	56	58	56	59	45	59
6	Feb	002	-	-	62	58	62	59	44	59
7	Mar	002	-	-	-	-	60	59	62	59
8	Apr	002	-	-	-	-	-	-	47	32

Table 1 illustrates the changes in weight over four months. The effect on the score is similar. The weight is updated each month as is the score; so that once a new month of data is received 'TD' scores will change from previous month. In the last month of a quarter the weight and score become locked in as the Q# weight and score. *Circled scores are locked.

The need to report scores on a monthly basis creates the need for a second weight. This monthly weight is used only for the month of reporting and whenever the need to restore a score from a previous month occurs. The monthly weight does not change once calculated as the quarterly score does.

The final weight needed is a yearly weight used for YTD and yearly scores. The yearly weight is calculated monthly. As with the quarterly weight, it is not finalized till the end of the time period (yearly). Each month a new yearly weight is calculated for all respondents. This weight is locked in at the end of the year.

The weights are also used to generate the weighted sample population estimates. As with scoring the weight should be matched to the period for calculating monthly, quarterly and yearly estimates.

Design Summary

- Using this method, each survey will be representative of households (businesses) in the PC. One survey will represent "x" households or business within a 3-digit ZIP CODE area.

- Weighted results reflect appropriate proportions of businesses or households.

- Results are rolled up to higher levels of aggregation using weights. Three weights for all roll ups. Monthly for month, quarterly for quarter/QTD and yearly for year/YTD data.

Weighting Detail

All respondents will be assigned these three weights. Each month the 3-digit ZIP CODE population is divided by the number of returns for the 3-digit ZIP CODE to develop the monthly weight:

$$\frac{\text{\# of households or businesses in 3-digit ZIP Code}}{\text{\# of monthly returns in 3-digit ZIP Code}} = \text{Monthly Weight}$$

This weight is static, once assigned it will not change. This allows monthly scores to be redone at any time by using the monthly weight.

These monthly weights will be more variable because returns are targeted for the quarter not the month. Monthly returns will be small because the returns will be spread out and the number of returns will vary as the monthly response rate varies. These factors affect the monthly weights and as the weight varies the monthly scores will also vary. This is one of the reasons for trimming weights. If the weights vary too much, some of respondents can have very high weights. High weights can lead to a respondent being overly represented in some levels of scoring.

The quarterly weight is calculated similarly. Thus the specific formula for the USPS quarterly weight is as follows:

$$\frac{\text{\# of households or businesses in 3-digit ZIP Code}}{\text{\# of quarterly returns in 3-digit ZIP Code}} = \text{Quarterly Weight}$$

The quarterly weight changes monthly. In the first month it is based on the returns from only the first month, and in fact is identical to the monthly weight for the first month in a quarter. This also means that the QTD and monthly scores are the same in the first month of a quarter, an expected result. The second month of a quarter the quarterly weight differs from the monthly weight since the quarterly weight will include

returns from both months in the denominator. Respondents from the first month will have their quarterly weight updated in the second month.

An important consequence of this changing weight is that as the quarter progresses a QTD score from a previous month cannot be recreated from a current data set. This is expected and the nature of a 'to date' score, but it should be noted. Generation of previous QTD scores will require use of stored weights. At the end of a quarter, once all the returns for a quarter have been received the quarterly weight will be finalized and for respondents in that completed quarter will not change again. This enables a quarter score to be recreated at any future time for a particular completed quarter with any current data set. In summary, for the quarterly weight:

- To-date score will be replaced when quarterly weights are updated each month.
- To-date scores will change with new quarterly weights.
- Quarterly weights will become static at the end of each quarter.

A yearly weight will be used for Yearly/YTD scores. Similar to the previous formulas the specific formula for the USPS yearly weight is as follows:

$$\frac{\text{\# of households or businesses in 3-digit ZIP Code}}{\text{\# of yearly returns in 3-digit ZIP Code}} = \text{Yearly Weight}$$

The yearly weight also changes monthly. In the first month of the year it is based on the returns from the first month and is identical to the monthly and quarterly weight for the first month of the year. This means that the YTD matches the QTD and monthly score as expected. The yearly weights from the following months will differ from the monthly and quarterly weights with one exception; the yearly and quarterly weights and scores will match at the end of the first quarter. Each month all respondents from previous months will have their yearly weight updated.

As with the quarterly weight as the year progresses a YTD score from a previous month cannot be recreated from a current data set. This is expected and the nature of a 'to date' score, but is noted for information. Previous scores can be generated using stored weights. At the end of a year, once all returns for a year have been received, the yearly weight will be finalized, and for respondents in that completed year will not change again. This enables a yearly score to be to be finalized. In summary, for the yearly weight:

- To-date score will be replaced when yearly weights are updated each month.
- To-date scores will change with new yearly weights.
- Yearly weights will be static at the end of the year for all respondents.

Therefore there will be three weights for each of the scoring periods, updated monthly, assigned to each respondent at the 3-digit ZIP Code level.

Aggregation of Scores

With S.W.A.P. weighting, scoring at different levels is relatively straight forward. Once the time period for scoring is determined then the same weight is used for all scoring above the weighting level. All monthly current or past scores will use the monthly weight. All quarterly and QTD will use the quarterly weight. All yearly and YTD will use the yearly weight. The next thing is to determine the level of scoring. For USPS Residential and Small Med Business CEM Survey Data the weighted scores are either the PC, Area or National level scores. Once the level, the time period and the weight are determined, then multiply weight by all respondents in desired level sum and divide by weighted sum to determine desired level score.

$$\frac{\text{Sum of (3-digit ZIP Code weight x all PC respondents score)}}{\text{Sum of all PC respondents weights}} = \text{PC score}$$

$$\frac{\text{Sum of (3-digit ZIP Code weight x all Area respondents score)}}{\text{Sum of all Area respondents weights}} = \text{Area score}$$

$$\frac{\text{Sum of (3-digit ZIP Code weight x all respondents score)}}{\text{Sum of all respondents weights}} = \text{National score}$$

NOTE: Weight is determined by respondent's 3-digit ZIP Code membership and the appropriate time frame of the return.

Weighting Considerations

- LEVEL OF WEIGHTING: Weights will not be applied to the 5-digit level. Sample sizes are too variable and not large enough to consistently weight at this level. Therefore, when reporting 5-digit ZIP information, scores will be not be weighted and no "households/business represented" population estimates will be reported
- TRIMMING OF WEIGHTS: Even weights at the 3-digit level can get extreme, so a trimming of weights will be done. Trimming weights refers to the process of putting an upper or lower limit on the size of a weight. If through the standard weighting procedure, a weight is deemed to be too extreme; its weight can be trimmed to a predetermined size. For this study any 3-digit weight representing more than twice what the weight would be for the whole PC's returns, will be limited.
- FREQUENCY OF WEIGHTING: All three weights, updated monthly.
- SOURCE OF POPULATION ESTIMATES: The number of business and residential addresses are derived from population estimates that are obtained from the sample vendor (currently MLX). The estimates will be updated on a quarterly basis. The population estimates will also be evaluated on a regular basis and an alternative source considered if necessary.

Weighting Formulas

$$\frac{\text{\# of households in 3-digit ZIP Code}}{\text{\# of monthly returns in 3-digit ZIP Code}} = \text{Residential Monthly Weight}$$

$$\frac{\text{\# of households in 3-digit ZIP Code}}{\text{\# of quarterly returns in 3-digit ZIP Code}} = \text{Residential Quarterly Weight}$$

$$\frac{\text{\# of households in 3-digit ZIP Code}}{\text{\# of yearly returns in 3-digit ZIP Code}} = \text{Residential Yearly Weight}$$

$$\frac{\text{\# of businesses in 3-digit ZIP Code}}{\text{\# of monthly returns in 3-digit ZIP Code}} = \text{Business Monthly Weight}$$

$$\frac{\text{\# of businesses in 3-digit ZIP Code}}{\text{\# of quarterly returns in 3-digit ZIP Code}} = \text{Business Quarterly Weight}$$

$$\frac{\text{\# of businesses in 3-digit ZIP Code}}{\text{\# of yearly returns in 3-digit ZIP Code}} = \text{Business Yearly Weight}$$

Weighting and Scoring Illustration

For a fictional USPS survey the following 2 areas and their PC's and corresponding 3-Digit ZIP CODES, we have the population numbers, returns and weights.

Area	PC	3-Digit ZIP CODE	Population	Returns	Weight
A			30000	2139	
	1		10000	1076	
		101	1250	140	9
		102	1000	128	8
		103	1000	112	9
		104	1250	90	14
		105	750	134	6
		106	750	80	9
		107	1000	109	9
		108	1250	80	16
		109	1000	130	8
		110	750	73	10
	2		20000	1063	
		201	13500	654	21
		202	6500	409	16
B			70000	2247	
	3		40000	1053	
		301	6500	238	27
		302	3500	55	64
		303	3500	233	15
		304	10000	128	78
		305	10000	210	48
		306	6500	189	34
	4		30000	1194	
		401	15000	634	24
		402	5000	198	25
		403	10000	362	28

For a fictional set of respondents in Area A, PC 2 we might have the following Scores:

Respondent ID	Area	PC	3-Digit ZIP CODE	Weight	Unweighted Frequency Top Two Box Q1	Weighted Frequency Top Two Box	Unweighted Frequency Top Two Box Q19	Weighted Frequency Top Two Box
1	A	2	201	21	1	21	1	21
2	A	2	201	21	1	21	1	21
3	A	2	201	21	1	21	0	0
4	A	2	202	16	1	16	0	0
5	A	2	202	16	1	16	1	16
6	A	2	202	16	1	16	1	16
7	A	2	202	16	0	0	1	16
Total				127		111		90

We can calculate scores for PC 2 using the formula for scores noted previously:

$$\frac{\text{Sum of (3-digit weight x all PC respondents score)}}{\text{Sum of all PC respondents weights}} = \text{PC score}$$

PC2 Top Two Box Score of Q1 = [(21*1) + (21*1) + (21*1) + (16*1) + (16*1) + (16*1) + (16*0)] / [21 +21 +21 +16+16+16+16] =111/127 = .874016 or 87.4% Top Two Box.

PC2 Top Two Box Score of Q19 = [(21*1) + (21*1) + (21*0) + (16*0) + (16*1) + (16*1) + (16*1)] / [21 +21 +21 +16+16+16+16] =90/127 = .708661 or 70.9% Top Two Box.

Further scores and higher levels would proceed in the same manner.

To calculate precision from a base size (proportions)

Variables input:

n	Base size
p_s	Sample proportion
N	Population
alpha	Desired confidence level

The critical value, z, is calculated from a Z-Table, based on the desired alpha.

Compute the precision:

$$D = z\sqrt{\frac{p_s(1-p_s)}{n}}\sqrt{\frac{N-n}{N-1}}$$